

# Python Optimization Modeling Objects (Pyomo)

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## Summary

The Python Optimization Modeling Objects (Pyomo) software is a Python package that can be used to define abstract optimization problems, create concrete problem instances, and solve these instances with standard solvers. Pyomo provides a capability that is commonly associated with algebraic modeling languages like AMPL and GAMS. However, Pyomo can leverage Python's programming environment to support the development of complex models and optimization solvers in the same modeling environment.

Algebraic Modeling Languages (AMLs) are high-level programming languages for describing and solving mathematical problems, particularly optimization-related problems [7]. AMLs like AIMMS [1], AMPL [2, 6] and GAMS [4] have programming languages with an intuitive mathematical syntax that supports concepts like sparse sets, indices, and algebraic expressions. AMLs provide a mechanism for defining variables and generating constraints with a concise mathematical representation, which is almost essential for real-world problems that can involve thousands of constraints and variables.

An alternative strategy for modeling mathematical problems is to use a standard programming language in conjunction with a software library that uses object-oriented design to support similar mathematical concepts. Although these modeling libraries sacrifice the intuitive mathematical syntax of an AML, they allow the user to leverage the greater flexibility of standard programming languages. For example, modeling libraries like FLOPC++ [3], OPL [5] enable the solution of large, complex problems within a user-defined application.

Pyomo is a Python package has many of the advantages of both AML interfaces and modeling libraries. Pyomo can be used to define abstract problems, create concrete problem instances, and solve these instances with standard solvers. Like other modeling libraries, Pyomo can generate problem instances and apply optimization solvers with a fully expressive programming language. Python is a powerful dynamic programming language that has a very clear,

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readable syntax and intuitive object orientation. Python's clean syntax allows Pyomo to express mathematical concepts with a reasonably intuitive syntax. Further, Pyomo can be used within an interactive Python shell, thereby allowing a user to interactively interrogate Pyomo-based models.

We currently plan to release Pyomo under an open-source license encourage its use by external collaborators. Pyomo can leverage the fact that Python is a noncommercial language with a very large user community, which will ensure robust support for this language on a wide range of compute platforms.

## References

- [1] *AIMMS home page.*
- [2] *AMPL home page.*
- [3] *FLOPC++ home page.*
- [4] *GAMS home page.*
- [5] *OPL home page.*
- [6] R. FOURER, D. M. GAY, AND B. W. KERNIGHAN, *AMPL: A Modeling Language for Mathematical Programming, 2nd Ed.*, Brooks/Cole-Thomson Learning, Pacific Grove, CA, 2003.
- [7] J. KALLRATH, *Modeling Languages in Mathematical Optimization*, Kluwer Academic Publishers, 2004.